DEVA User Guide

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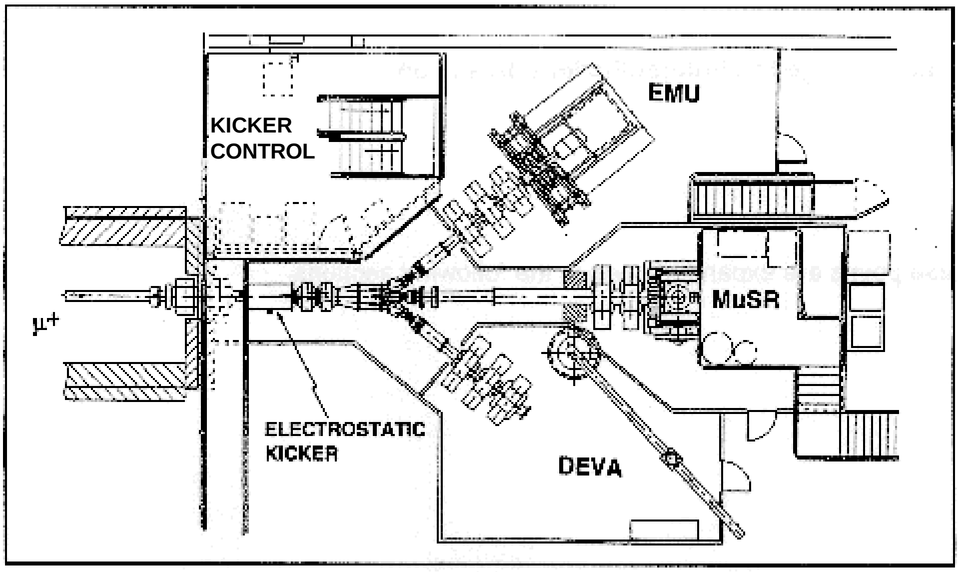
Version 1.0

Contents

1. Getting Started

This manual describes the DEVA instrument as used with the "RF" spectrometer, for either normal muon spin relaxation or RF resonance experiments.

1.1. Layout of Muon Instruments



1.2. Interlocks

1.2.1. Closing the area

- Check no-one is in the area, and press the Search Button
- Close and bolt the door
- Remove the key (DEVA-S) and put it in the blue interchange box. Once all spaces are filled, the master key is released
- Remove the master key (DEVA-M) from the blue box, this locks the other keys in place
- Put the master key in the green interlock box and turn clockwise (90º)
- Turn the Helmholtz Interlock key to the vertical position. (Do not turn the key until this stage or the magnet will trip off.)
- Press and hold "Raise" until the green light goes out
- Turn the Helmholtz Interlock key to the horizontal position
- The blue lights in the area come on to indicate that the beam is on.

1.2.2. Opening the area

If you want to leave the field on, first turn the Helmholtz Interlock key to the horizontal position and leave it there. Otherwise it may be necessary to reset the magnet supply next time it is used.

- Press "Lower"
- Once the blocker has closed and the blue lights have gone out you can remove the master key from the interlock box
- Put the master key in the interchange box and remove one of the other keys
- Unlock the area door.

2. The Beam

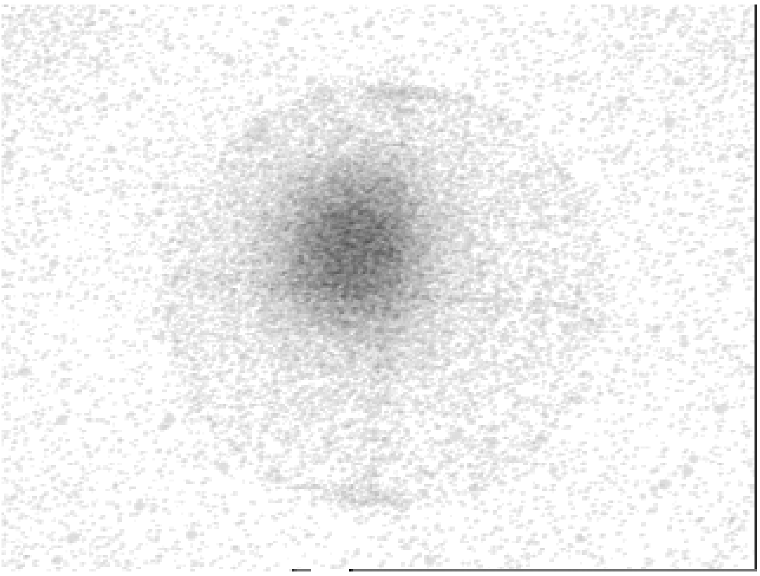
2.1. Steering

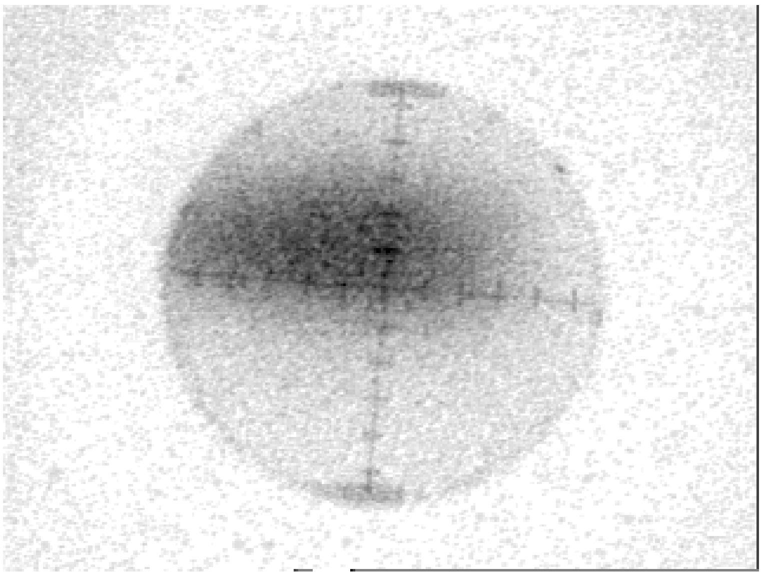
The alignment laser mounted on the beam stop indicates the beam centre. The cryostat should be lined up with it (X on tail, or centre of exit window) by adjusting the nuts on the mounting plate.
There is a vertical steering magnet controllable from the Farnell supply in the cabin, normally left at zero (switched off). It will give 4 mm/Amp. with +ve current moving the beam UP. A limited amount of horizontal steering can be obtained by adjusting the septum magnet – ask your local contact about this. Both reduce the beam intensity if steered too far.

2.2. Slits and sample size

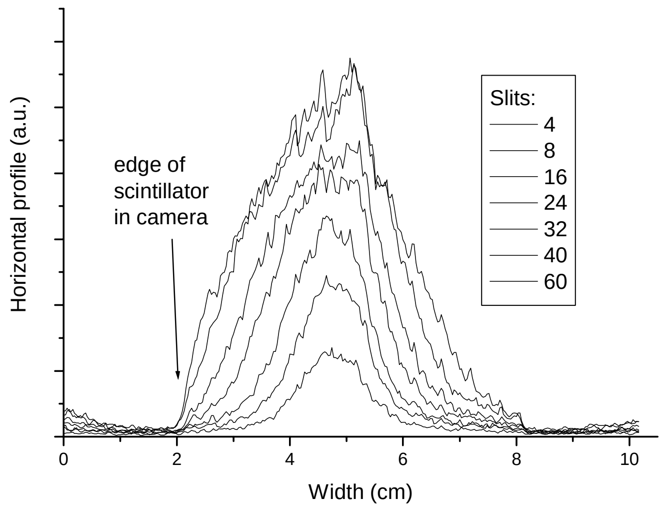
The slits adjust the horizontal spot size and also the intensity of the beam (count rate) although the spot size reaches a minimum below slits=10. The vertical size remains the same.

Pictures from the beam camera for slits=8 and slits=60 – the outline of the camera's scintillator (6cm diameter) and graticule can be seen. (Actual size)

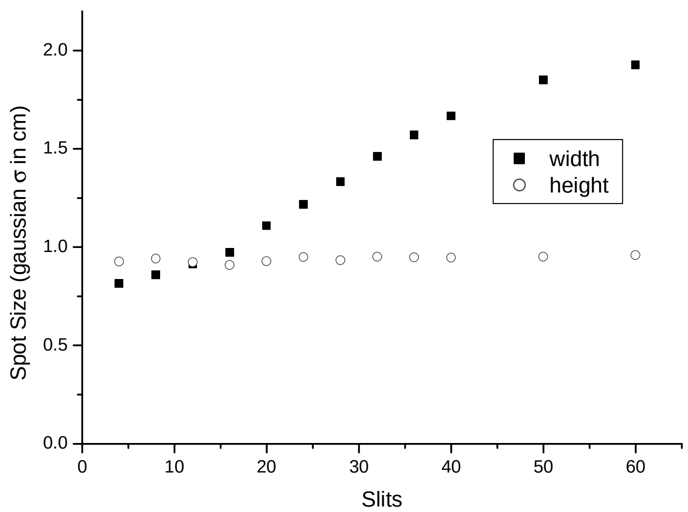


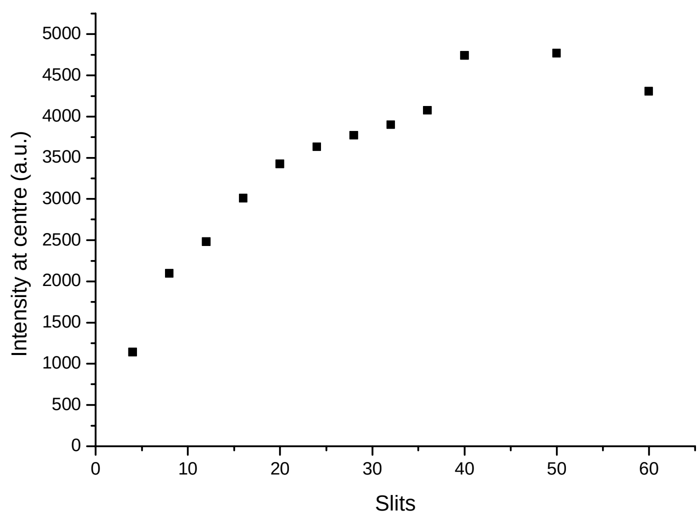


Profiles taken from the beam camera for a number of slit settings:



The beam pictures can be fitted to a Gaussian profile. Parameters are shown here:



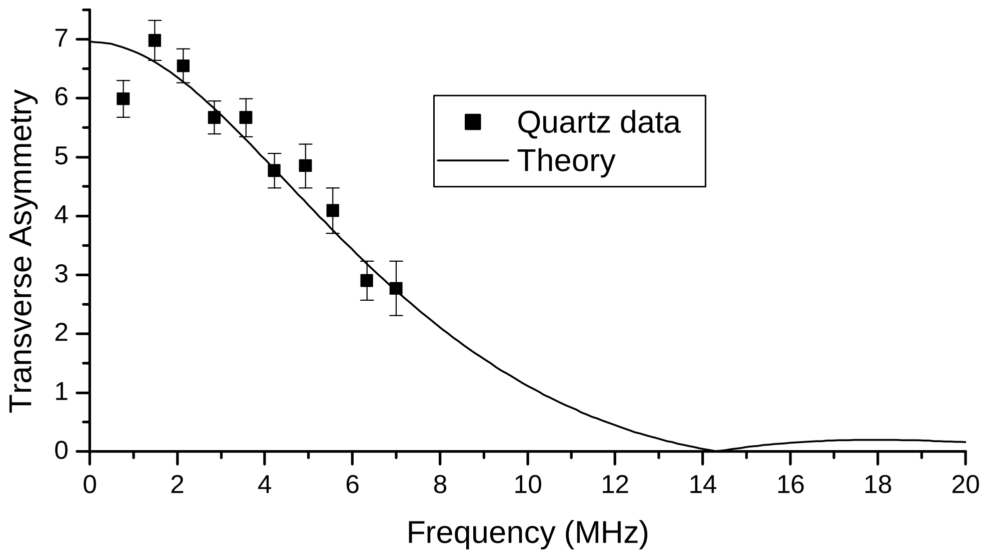


With a mask of 20mm diameter, a slit setting of 8 is found to give 75% of the muons on the sample. To maximise the counts on a small flypast sample, use a slit setting of around 20.

The slits are adjusted from the rack in the kicker control area, down the steps behind EMU. Be careful to adjust only the DEVA slits.

2.3. Frequency response due to pulse width

At ISIS the muons are produced in large numbers in short pulses (about 80ns wide at half height) and the approximation is usually made that an average arrival time near the centre of the muon pulse can be used as time-zero. This is adequate if the time-scale of the evolution of the muon polarisation is long compared to the width of the muon pulse but leads to difficulties in cases where the evolution is rapid. The effect is seen clearly by considering a transverse field experiment performed at a succession of magnetic fields. At low fields the frequency is small and the polarisation precesses with full asymmetry. As the field increases there is an appreciable phase difference developed between muons from the beginning and end of the pulse and the observed asymmetry falls. This frequency response has been measured by observing the precession of muonium in quartz in small transverse fields, the results are shown below.



With RF precession measurements, where the muons are implanted in longitudinal field and then rotated through 90º by an RF pulse, the pulse width does not matter. In this case the only limiting factors on the frequency response are the precision of the detectors and electronics and the bin width of the histogram.

2.4. Detectors

The positrons produced when the muons decay are detected with scintillators linked to photomultipliers.

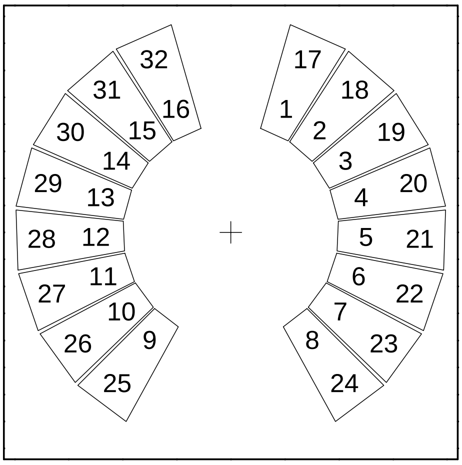
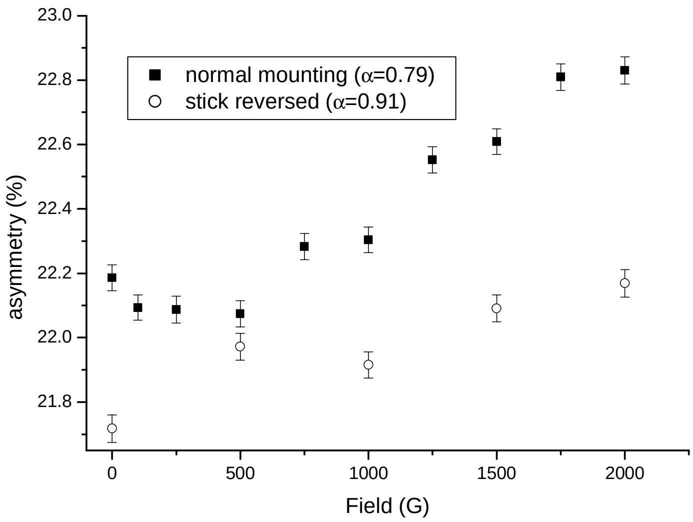


Diagram looking upstream. Detectors 1-16 are “forward”, 17-32 are “backward”. Angles around the beam axis from vertically upwards are 24, 41, 58, 75, 92, 109, 126, 143 degrees. Looking from the side or top the detectors are at approximately 45 degrees away from the beam axis.

The photomultipliers are powered from the Lecroy HV supply in the cabin. Users should not normally have to change anything.
Channels 0-31 correspond to MCS histograms 1-32. Voltages may be anywhere in the range -1000 to -2000 volts depending on the individual tube’s properties.
Select the channel to display by pressing CHANNEL and UP or DOWN.
Change the setpoint by pressing VOLTAGE and UP or DOWN.
Turn all channels on or off with the HV ON and HV OFF buttons.
If a detector develops a light leak (large background number of counts in the later time bins) turn its voltage off to prevent damage.

2.5. Asymmetry shift with field

The high magnetic fields affect both the trajectory of the positrons and the sensitivity of the photomultiplier tubes, and can cause small changes of asymmetry.



The above graph is for a silver plate in two positions, in the flow cryostat. If this matters for your experiment you should perform a similar measurement with a setup as close to your actual experiment as possible.

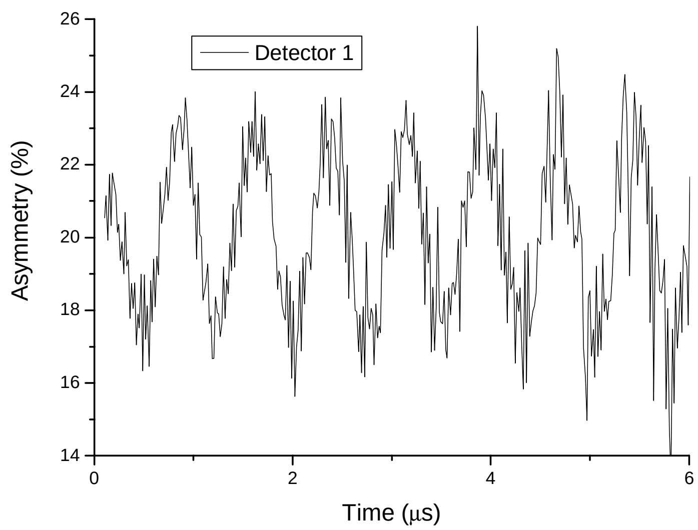
2.6. Time zero

This is the "average" arrival time of the muons in the pulse, measured from the start of the histogram. It is calibrated by measuring muon precession in a series of different transverse fields and extrapolating back to the point when all the phases are equal. The latest value is saved in the file "basetime.uda" (kept in MUT$DISK:[MUTMGR.MUT_USERS.UDA] and copied to the current directory when setting up the data analysis program UDA)

The value of t0 will be different between the Lecroy and DASH2 TDC systems and completely different if triggering via a RF pulse generator. Cable lengths are significant: adding about 3m of extra cable length moves the data by one 16ns bin.

The first good data bin is about 0.1 us after t0, when all the incoming muons have arrived. Some of the detectors may also show a peak around time zero due to muons decaying in flight in the beamline and the positrons produced not being properly focused and striking the detector directly.

For transverse field runs, the phase at time zero is actually about +3 degrees due to the rotation of the muon spin in the kicker in a horizontal plane (actually the lack of matching rotation of the spin as the muons are deflected by the electric fields). There is also a rotation of about 6.5 degrees in the vertical direction due to the separator. The overall effect is that the muon spin points slightly up and to the left (looking upstream), ie. towards detector 16. The combined spin rotation is visible as "wiggles" of amplitude about 2.5% if looking at individual detectors in longitudinal field runs (20-200 Gauss).



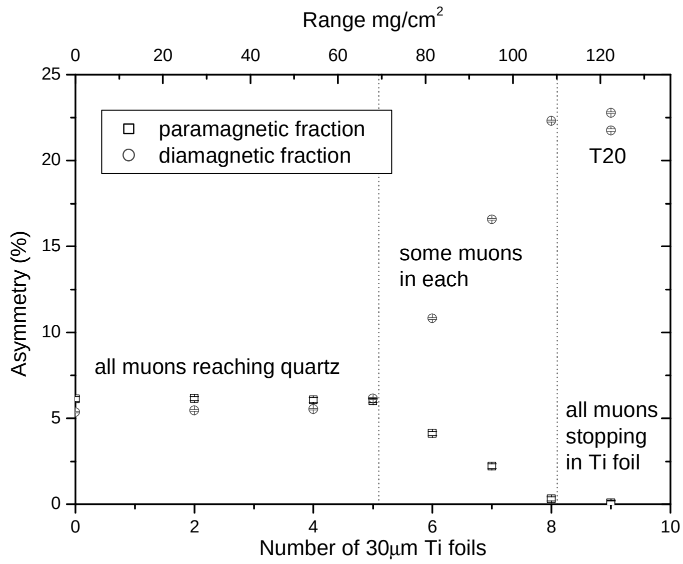
Silver, 100G LF (run 35709). Asymmetry plot of one detector only.

2.7. Dead Times

If two muons decay within a short interval of time and their positrons both reach the same detector, only one event may be counted. The minimum time to resolve two events is the "dead time" for that detector. This effect causes distortion, mainly at the start of the histograms when the muon count rate is highest.
Asymmetry plots tend to hide the distortion as both forward and backward counts are reduced.
The data can be corrected for this effect – our data analysis programs do this. However at very high count rates the correction becomes inaccurate. A count rate of 20-30 Mevents/hour is a reasonable compromise between high distortion and inefficient use of the beam.
The most recent calibrated dead time values are kept in the file DTMPAR.DAT in MUT$DISK:[MUTMGR.MUT_USERS.RUMDA] . Another copy of this file is in the data directory (MUT$DISK0:[DATA.MUT] or \\NDAVMS\MUTDATA as seen on the PC). If you are analysing older data, old dead time files are preserved with names DTMPAR_*date*.DAT .

2.8. Muon stopping range and sample thickness

The muons are produced with energy 4 MeV but slow down by interaction with matter. Their range is dependent mainly on the mass per unit area. Some of this range is taken up by the beamline and cryostat windows. Ideally all the muons should stop in your sample, not the window or the back of the sample cell.



This measurement was taken in the "high temperature" flow cryostat. It uses a 2mm thick quartz sample with a number of 30μm Ti foils in front, and a small applied transverse field. Signals from paramagnetic muonium (in the quartz) and diamagnetic muons (some in quartz, full asymmetry in Ti) are measured.

For a thin sample, a "degrader" of about 70mg/cm^2 equivalent to 5 Ti foils can be used, including any window on a sample cell. The sample itself should ideally have minimum "thickness" of 40 mg/cm^2. It is best to choose a degrader whose own muon signal is easily distinguished from that of your sample, and add or remove foils to find the optimum thickness.

The degrader must be as close to the sample as possible, as it will scatter the muons and could increase the muon spot size.

3. Sample Environment

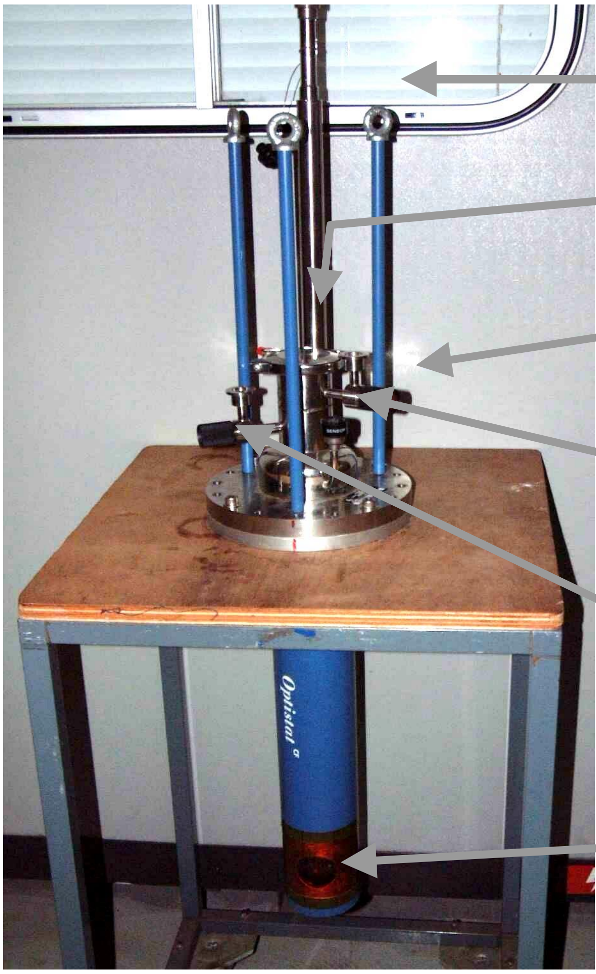
3.1. Flow Cryostats

There are two flow cryostats:

- The standard one with temperature range 3.5 to 400K, with an exit window
- The high temperature cryostat, with temperature range 4 to 600K.

Liquid helium is taken from a storage dewar via a needle valve and passes through the inner tube of a concentric flexible transfer line. It flows through a heat exchanger near the sample before returning (as gas) along the transfer line and to the pump. The sample is in a separate “static” exchange gas at typically 10-15mbar. An ITC5 temperature controller controls the valve and heater.

The standard temperature flow cryostat, in its storage trolley (shown with the muon entry window facing: when in the instrument it will be rotated through 180º)
MUSR2002 MUSR2002



The sample sticks are interchangeable but only those designed for high temperatures (with glass fibre wrapping around the central rod) are suitable for use above 400K. Also ensure that your sample and its coil or holder will cope with the expected temperature range.

3.1.1. Samples

The cryostat has helium exchange gas around the sample.

This cryostat can use the same sample holders as the EMU “Blue” cryostat: 37mm square with mounting hole spacing 30mm, or a “flypast” holder made of a thin strip of silver sheet. The internal diameter of the cryostat is 43mm.

For RF experiments the sample size depends on the coil used but a typical size is 25mm square and up to 4mm thick. Powders must be enclosed in a non-conducting containter such as a Mylar envelope.

3.1.2. Installing

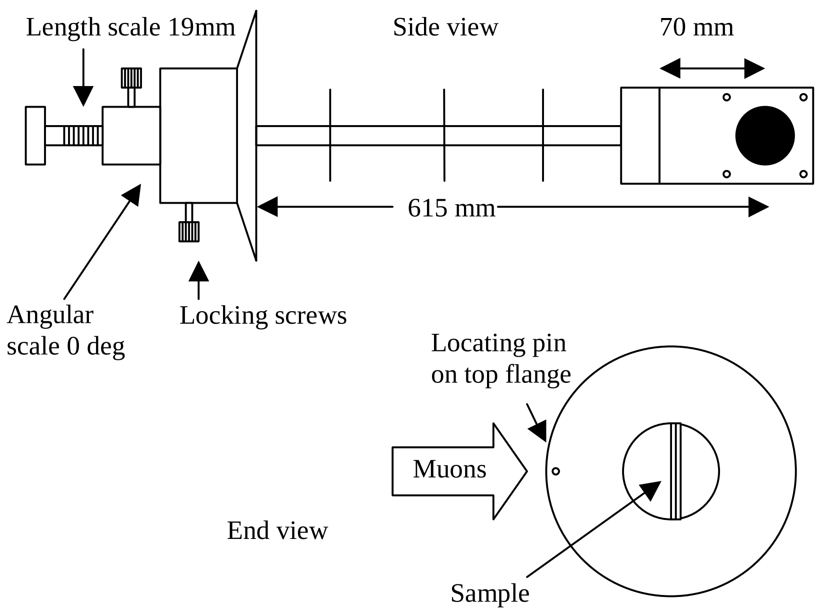
The cryostat fits into the top of the magnet frame, bolted to the support plate using 4 of the bolts on its flange. Check the alignment with the laser and adjust the bolts holding the support plate to the frame if necessary.
Use the appropriate ITC5 temperature controller for the cryostat (DEVA Flow 1 for the lower temperature cryostat)

To minimise stress on the sample space windows ensure the cryostat vacuum space (OVC) is at vacuum before pumping the sample space. Pump the OVC (lower of the two small taps) using a portable turbo pump set.

3.1.3. Connections

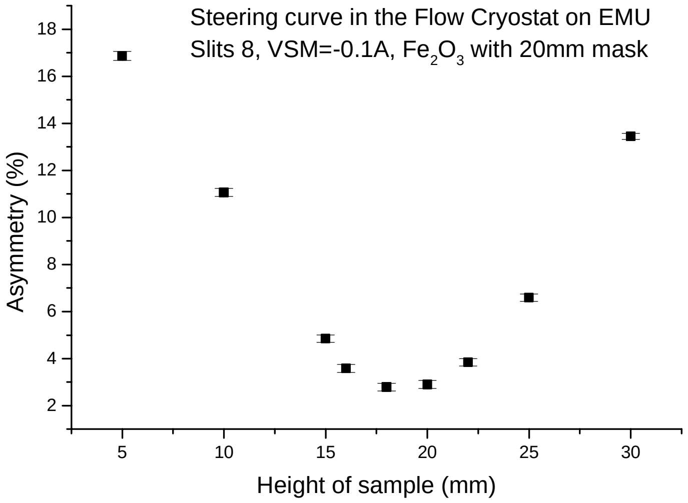
- Cryostat sample space port to a T piece. One branch goes to a rotary pump (with pressure gauge and valve), the other has a valve and adaptor for the red helium line.
- Cryostat heater/thermometer to ITC channel 1
- Stick thermometer to ITC channel 2 (stick A) or 3 (stick B)
- Transfer tube needle valve to ITC Aux. Out
- Transfer tube gas outlet (at the top of the dewar leg) to the pumping box via a long plastic tube
- Serial cable (from the optical fibre modem) to this ITC5 serial port

3.1.4. Mounting the sample



With the standard blade and sample holder, the length from the bottom of the copper block to the sample centre is 70mm and the top adjustment should be set to 19mm. If a non standard sample mount differs from 70mm, adjust the top scale by the same amount. The overall length from flange to sample centre is 615 mm.

For the standard blade, set the angle to 0 degrees. The muon arrival direction is in line with the locating pin on the top flange and the sample plate should normally be perpendicular to this. You can rotate the sample relative to the beam if required by your experiment, either now or when in the cryostat.



3.1.5. Inserting the stick

The sample can be changed when the cryostat is cold, but heat it up to >25K first.

- Let the sample space up to 1 atm with helium.
- Remove the blanking plate
- Insert the stick: the pin on the stick flange should locate into the hole in the flange on the cryostat.
- If the cryostat is cold, the stick may not go all the way into the cryostat – the copper cylinder on the stick is designed to fit tightly into the heat exchanger and thermal expansion can prevent it fitting. Either leave the stick partially inserted and wait a minute, or warm the cryostat.
- Pump the sample space, purge two or three times with helium, and set the exchange gas pressure to 15 mbar.

3.1.6. Inserting the transfer line and cooling

This requires two people and you may also need a stool to be able to lift the transfer line high enough.

- Lift a Helium dewar onto the platform inside the area (requires someone with a crane licence).
- Remove the dewar neck insert/yellow valve by undoing the KF50 clamp and fit the one with the level meter probe. Do this carefully but quickly to avoid getting air into the dewar.
- Connect the helium level meter cable.
- Remove the protective cover from the cryostat end of the transfer line. Check that the PTFE sealing washer is present on the cryostat end of the transfer tube.
- Connect the needle valve cable. Turn the ITC5 on. This initialises the valve.
- Open the needle valve fully: press and hold "Gas Auto" and then press "Raise". Check it stays in Manual (light off).
- Insert the long leg of the transfer tube in the dewar. **Be very careful not to bend the transfer tube** – the second person should support the cryostat end. Reduce pressure in the dewar as required with the red valve. The tube should end up standing on the bottom of the dewar with about 10cm length still visible.
- The second person should put the transfer tube into the cryostat **once it will reach without bending the dewar leg** and tighten the locking nut. Turn on the diaphragm pump. Open the valve on the pumping box. There should be a small but non zero flow.
- After about 5 minutes the flow should increase as liquid reaches the cryostat, and the temperature will start to fall.
- The Green valve on the dewar should be open and the Red valve closed during operation.

If the cryostat is still not cooling after 20 minutes, the tube may be blocked with ice or solid air:

- Remove the transfer tube from the cryostat and dewar.
- Warm both ends with a hot air blower. Dry with paper tissues.
- Blow clean helium gas through it – use a piece of rubber tube over the cryostat end.

3.1.7. Computer control

Type @FLOW_ITC502 to set up the computer, then set temperatures with SET TEMP/SET=*x*. The range is 4 to 400K for the low temperature cryostat or 4 to 600K for the cryofurnace. Temperatures slightly below 4K can be obtained by careful adjustment of the needle valve in “manual” mode.

The computer uses two thermometers.
One is on the cryostat heat exchanger, labelled Readback on the computer and plotted as a dotted red line on the graph. The temperature controller uses this to control the heater, and the computer uses it to decide when the temperature is stable at a new setpoint.
The second is on the sample stick. This is labelled “Sample” on the computer, plotted as a solid white line, and recorded in the log file.

3.1.8. Changing Samples

- Warm the cryostat to 25K or above.
- Remove the KF50 clamp holding the sample stick in place
- Let the sample space up to 1 atm with helium
- Remove the sample stick
- Unless you have another sample stick ready, put the blanking plate on the cryostat and pump out the sample space.

3.1.9. Changing the Dewar

Check the level regularly. Full is about 550mm, don’t go below about 50mm. A dewar may last from 2 days to a week depending on the temperature the cryostat is running at (below 10K uses rather more helium). The sample can be left in place during the changeover although the temperature may rise.

- Turn off the diaphragm pump.
- Open the needle valve to 99.9%. Wait for the pressure on the pumping box to reach atmospheric.
- Remove the transfer line **being careful not to bend its legs** and put it in the support tray.
- Exchange the dewar, put the insert with the level meter into the new one.
- Warm the transfer line with the hot air blower and dry it with paper tissues.
- Blow helium gas through the transfer line for a minute or two – put the red gas line on the cryostat end with a piece of rubber tube.
- Re-insert the transfer line as above. If the cryostat was cold, the temperature will rise initially until liquid reaches it.

3.1.10. Removing the cryostat

- Warm the cryostat to 25K or above.
- Ensure the needle valve on the transfer tube is open (set the ITC5 to Local, then press Gas Flow and Raise) then shut the valve on the pumping box. The pressure should rise rapidly to 1 atm. If it doesn’t, check with your local contact.
- The transfer line can then be removed. **Be careful not to bend either of the legs**. Fit the protective cover over the cryostat end of the transfer line and put the stopper into the cryostat.
- Unplug all the electrical leads from the cryostat. Close the sample space valve and disconnect the sample space pumping line.
- Close the vacuum valve and switch off the turbo pump. Remove the vacuum line.
- Unbolt the cryostat and lift it out.
- Remove the level meter probe and replace the normal dewar neck insert.

4. Magnetic Fields

4.1. Longitudinal Field

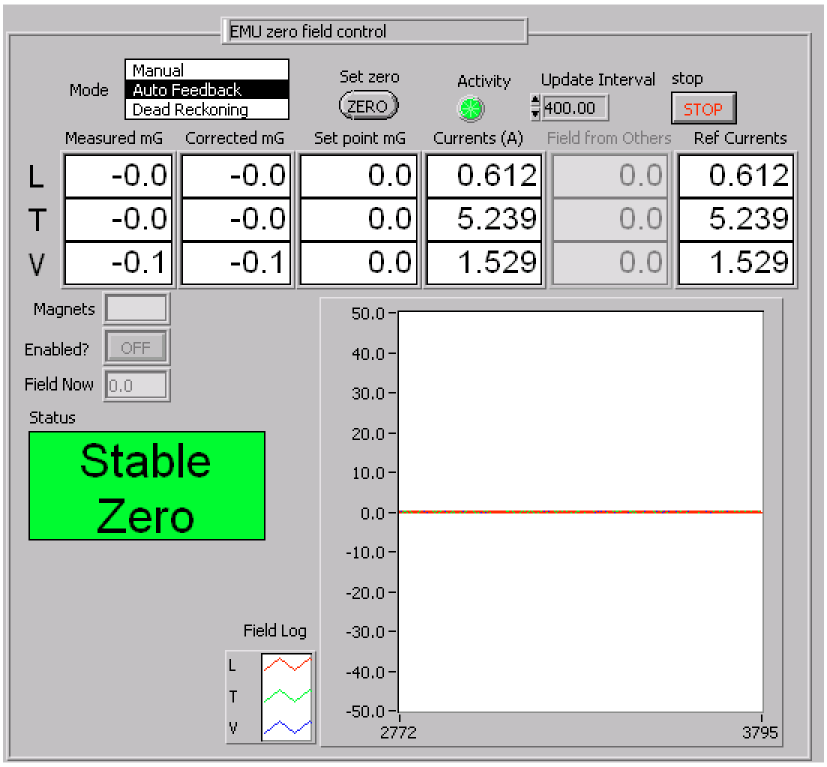
This is provided by the large water cooled Helmholtz coils, powered from a Danfysik supply located next to the beamline magnet supplies. It is controlled from the computer in the cabin. The maximum field is 2100 Gauss.
From MCS type “@LF0” to select it then “SET MAG/SET=*x*” as required.

4.2. Transverse Calibration Field

This uses two small coils inside the main magnet, powered by the Thurlby Thandar supply in the cabin, also under computer control. The maximum is 30 Gauss. The field is Vertical.
Type “@TF20” to turn it on and set 20 Gauss, and then “SET MAG/SET=*x*” if a different field is required.

4.3. Zero Field setting

This is automated using a triple axis fluxgate probe and three pairs of compensation coils. Control is via a Labview program on the PC – under the “Zerofield” tab in Ray of Light, in turn controlled from MCS.



Operating modes are:

- Auto Feedback: the probe is read and used to control the currents, to keep the field at the set point. This is usually zero but can be any field up to the limit of the probe (5 Gauss) and in any direction. This mode is activated by “@F0” in MCS.
- Manual: the probe is read but its value is not used. The currents are left at the last set values, or you can type in new values. This is activated when one of the other magnets is selected in MCS.
- Dead Reckoning: the probe value is read but not used. The currents are adjusted as the main magnets on the other instruments vary, to keep the field in DEVA steady. You can adjust the field setpoint.

Either Hold Current or Dead Reckoning must be used if you are applying a field with the main longitudinal or transverse coils, otherwise the zero field system will try to cancel it out.

5. Data Acquisition

5.1. Electronics

Either the DASH2 system (as used on EMU or MUSR) or the Lecroy TDC can be used. The Lecroy offers bin sizes down to 0.5ns for RF free induction decay runs (but it is best to select 2ns or above if the high frequency response is not needed, as the bin sizes are non uniform at faster settings)

5.2. MCS

MCS is the control program used to collect data. It is the same as used on EMU and MUSR.
For historical reasons the computer is called MUT, not DEVA, together with related things like the account names and disks.

5.2.1. Running MCS

Log into the Alpha workstation (MUT) as user MUT. Ask your local contact for the password.
You should get a DECterm window. Type “MCS” to start the data acquisition program, which will open some more windows.

5.2.2. Commands

NEW	begin a run. Asks for details for the file header – does NOT actually set the temperature etc.
STOP RUN	pause data collection
STOP RUN/AFTER=*ee*	arranges to pause the run when *ee* million positrons (MEvents) have been counted (then you get a message and beep)
START RUN	resume data collection
CLEAR	throw away data collected so far this run
SAVE	save the run (and last chance to change the label)
SET TEMP/SET=*t*	set the temperature of the cryostat to *t* K
SET TEMP/GAS=MAN	sets the helium valve to manual operation, leaving it at the same setting
SET TEMP/GAS=MAN=*m*	set the valve to position *m* (0 to 99.9%)
SET TEMP/GAS=AUTO	sets the valve to automatic when the next setpoint is sent
SET MAG/SET=*m*	set the field to *m* Gauss
EXIT	end MCS
RECOVER	read in saved temporary data after a crash, then use SAVE
@*filename*	execute the script *filename*.COM containing MCS commands
SYS *cmd line*	execute DCL command *cmd line*
@F0	select zero field and enable auto zero feedback, all main magnet supplies off
@LF0	set up Longitudinal supply ready for use, set to zero
@TF20	set 20G transverse field for calibration
@FLOW_ITC502	set up for the low temperature flow cryostat
@HTFLOW_ITC502	set up for the cryofurnace
@LECROY	set up the Lecroy TDCs
@DASH2	set up the DASH2 TDCs
SET MACQ/RGMODE	set Red-Green mode
SET MACQ/NORGMODE	set normal acquisition
SET MACQ/RESOLUTION=*p*	set TDC bin width in ps (usually 16000 or 8000 with the DASH2 system, 500,1000,2000...16000 with the Lecroy)
SET HIST/LEN=*l* SET HIST/GOOD=END=*l* /ALL	to change histogram length in bins (both required)
SET MACQ/READ=NFRAMES=*n*	read out data and change between red and green every *n* frames (ISIS pulses) – typically use 500 to 5000
SET MACQ/SAVE=*s*	write data to disk every *s* readouts – typically 1 to 6
SET DISP/FIRST=*f* /NUM=*n*	which histograms to display
SET DISP/LEFT=*lll* /RIGHT=*rrr*	range of time bins to display
SHOW TEMP	temperature values
SHOW TEMP/PAR	temperature control (PIDs etc)
SHOW MAG	field value
SHOW RUN	counts per histogram, etc.
SHOW MACQ	data acquisition parameters
SET LABEL	change the label (header) of the current run (if unsaved) or that to be used for the next run

5.3. Scripts

The program MKSCRIPT2 is used to write scripts.
From MCS type SYS RUN MKSCRIPT2 , or from another DECterm window type RUN MKSCRIPT2

Select from the menu using the initial letter of each command or the arrow keys, then RETURN. The mouse will not work.

Add: add an entry to the script. This can scan through several fields or temperatures taking a run at each. Press RETURN to use the default KEEP if a value is the same as the previous entry rather than retyping the same temperature or field – this also makes the script run faster as it doesn't have to wait for stabilisation each time.
T20: add a T20 measurement run (selects Transverse field and sets it to 20 Gauss, collects data, then selects the Longitudinal supply again)
Delete: remove an entry
Undo: reverse the last change
Read: read in a previously saved script for editing
Write: write the script to disk so that MCS can run it
Print: print a summary of the script (if you do this after Write, it puts the script name on the printout)
Help: simple online instructions
Quit: return to MCS or the DCL command line

Use the PAGE UP/PREV and PAGE DOWN/NEXT keys to scroll through the script if it is too long to fit the screen.

Putting KEEP for both the field and temperature of the first entry means it assumes you will have already set the temperature/field and started the run and the script only waits for the required counts. Putting a count limit of 0 for the last run means it leaves the run counting when the script finishes, and you have to stop and save it manually.

To scan temperature or field, type *first last step* at the Temperature or Field prompt, instead of a single number. The *last* value wil be rounded if required to give a whole number of steps of the size specified. The number of steps calculated is printed as confirmation. You can scan up or down, enter a positive value of *step* in both cases. You cannot scan temperature and field at the same time.

You can also scan fields on a log scale (up or down). Enter *first last –runs* where *runs* is the number of runs required. The ratio between successive fields will be printed as confirmation.

Normally fields in a script mean Longitudinal, and you should be sure the longitudinal field is selected with @LF0 before starting a script which is to set fields. If you execute a script when the Transverse supply is already in use, any field setpoints will use it (until a T20 entry is reached).

The script will update the field and temperature values in the label (file header) when it changes the actual field or temperature. Before running a script that starts the first run itself, check that the other entries (sample name, comments, etc) are correct. Set them with the MCS command SET LABEL.

The script is saved in a file of the form *name*.COM
To run it: type "@*name*" in MCS.

To interrupt a script in progress: press CTRL-C.
This does not stop the current run, although the run will stop when the pre-set number of counts are reached. You can stop and save the run manually.

To resume the script, first read it into MKSCRIPT2 and edit it to remove the entries which have been run. Also you may need to change the current run (which will now be the first in the script) to have KEEP for temperature and field. Write it back to the file, exit MKSCRIPT2 and restart with @*name*.

Experienced users may want to edit their scripts with the VMS editor. They contain a header which MKSCRIPT uses when reading a script in, but is ignored by MCS (each line starts with "!".) This is followed by the actual commands executed by MCS.

6. Computing and Data Analysis

6.1. Computers

- MUT (Alpha/VMS workstation): the instrument data acquisition computer. Can also be used to access ISISA.
- ISISA (Alpha/VMS central server): available for data analysis with UDA, etc.
- User PC (Windows): available for data analysis. Has WiMDA, Origin, Microsoft Office, Internet Explorer, etc. and eXceed to connect to the VMS machines.
- Labview PC (Windows): controls the zero field and other sample environment. Not for general use.
- A Unix / Linux service is available, contact Computer Support. Access is via Telnet or eXceed from the PC.

6.2. MUT01 and UDA

The account MUT01 is available for VMS data analysis. Alternatively you can use your own account.
Log in to the account MUT01 using Exceed on the PC, using SET HOST ISISA in a spare DECterm window on MUT, or Telnet to isisa.nd.rl.ac.uk from off site. Ask your local contact for the password.
Select one of the user areas offered by typing the name (or ask your local contact to set up a new one).
Next type SETUP
Now you can use UDA etc as on EMU or MUSR. For instructions on using UDA, see the next chapter.
The nearest printer is SYS$LSR10 just outside the EMU cabin. Others are SYS$LSR5 in MUSR or SYS$LSR2 in the DAC.

6.2.1. Convert_ASCII

This converts the binary data files produced by MCS into ASCII suitable for reading into general purpose data analysis programs or spreadsheets. Type CONVERT_ASCII.
The output formats are:

- Histograms listed individually (.USR format)
- Histograms as columns, with a time column at the left (easier to read in)
- Asymmetry and its error bars

There is an option to apply dead time correction to the data. Depending on the format, you can also specify alpha, the detector grouping and time zero.
A batch of files can be converted at once.

6.2.2. TLOGGER

Type TLOGGER to run the program to plot out the temperature log files. Printouts are left in files named PGPLOT.PS in the current directory, with one file version per run plotted.
Print them with PRINT /QUEUE=SYS$LSR10 PGPLOT.PS;*

6.2.3. RUMDA

This is available on VMS. See the separate manual.

6.3. WiMDA

This is set up on the PC in the cabin. See the separate WiMDA Manual for instructions. You should make your own subdirectory under D:\users and store temporary files there. The PC disks are NOT backed up, and old files may be deleted to free up disk space, so take a copy of anything valuable when you leave.
The data is accessed via the shared drive \\NDAVMS\MUTDATA . From other PCs on site you may need to connect to it before WiMDA can load data.

6.4. Taking your data home

6.4.1. FTP

From outside ISIS connect to isisa.nd.rl.ac.uk and log in either under your own account or MUT01. Alternatively use the FTP command on VMS or WS-FTP on the PC to PUT files to your own FTP server.
Data recently collected is in MUT$DISK0:[DATA.MUT]R*nnnnn*.RAL and temperature logs in MUT$DISK0:[DATA.MUT.TLOG]R*nnnnn*.TLOG
Data restored from the archive is in SCRATCH$DISK:[MUTMGR.RESTORE]
Files created by UDA, CONVERT_ASCII, etc are in SCRATCH$DISK:[MUT01.USERS.*areaname*]
Raw data files must be transferred as Binary, TLOGs as ASCII.
There is no FTP access into the PC network or off site access to shared PC drives.

6.4.2. CD-ROM

The PC in the cabin has a CD writer. Files should be copied to the local disk first. Ask your local contact for a blank disk. If you are taking raw data files, you should also take a copy of the dead time calibration file.

6.5. Archiving

All data is written to the ISIS data archive as soon as it is saved from MCS. The original files are kept on the local disk as long as space permits – usually a year or so.
To restore data for runs *run1* to *run2* inclusive type (in VMS)
RESTISIS mut *run1 run2*
and for temperature logs
RESTISIS –l mut *run1 run2*
Data is put into SCRATCH$DISK:[MUTMGR.RESTORE] where our standard programs know to look for it.
Use RSTATUS to show the progress. Some files are on tape and must be manually loaded during the next working day. More recent files may take only a few minutes to return.

7. UDA

7.1. Introduction

UDA is the simplified μSR data analysis program. There are three menus in UDA, the Main Data menu, the UDA data Grouping menu and the UDA data Analysis menu.

On start-up the program will always enter the Main menu. At this menu you can read and write data files, plot spectra and make changes to the data loaded.

In the data Grouping menu you can select how to map your raw histograms into the "groups" that are used when plotting or analysing. Two different grouping schemes can be used, the Simple (straight, TF) grouping, or the F-B (LF,ZF) grouping. Deadtime correction of data is available using the same correction method as the RUMDA analysis program.

In the Analysis menu you can select a model function and make a least-squares fitting of the model parameters. The fitting result can also be plotted from this menu.

7.2. Running UDA

To access UDA from account MUSR01 type SETUP followed by UDA as described in section 6.3. This will run the most recent version of UDA. The display will be redrawn as a dashboard and the cursor will automatically select the option MCSFILE in the Main menu. To select any other item from the menu use the cursor (arrow) keys or simply type the first letter of that item (e.g. ‘P’ for PLOT).

7.3. The Main Data Menu

The Main Data menu allows you to read, write and modify experimental data. The options available from this menu are listed below. Plotting of error bars on data points can be turned off/on using the SETUP option.

MCSFILE	Read a MCS run file in the format used by the data acquisition software
USRFILE	Read a uSR file from the disk
OLDFILE	Read one of the old (PDP) run files
WRITE	Write (grouped) data to a uSR file
INSPECT	Inspect run and all histograms
GROUP	Enter the Grouping Menu
CHANGE	Change run file parameters
PLOT	Plot one or more groups on the terminal screen
ANALYSE	Enter the analysis menu
SETUP	Set program configuration parameters
HELP	Enter the VAX/VMS help facility to read the UDA help library.
QUIT	Exit UDA and return to VMS prompt

7.4. The Grouping Menu

The grouping menu is accessed through the option "Group" from the Main menu, and defines the grouping and correction of raw histogram data. There are currently two ways of grouping the histograms:

a) the Simple grouping, where histograms are simply added together.

b) the Forward-Backward (F-B) grouping, where the 'asymmetry ratio'
$(F-\alpha B)/(F+\alpha B)$ is calculated.

Deadtime correction of data is turned on/off using the DeadT option. To compensate for deadtime, UDA uses the same file of deadtime values as the RUMDA analysis program, generated at the start of each cycle from a long silver run. Please ask your local contact if you are analysing data from a

previous cycle and so require UDA to use deadtime values from that cycle rather than the current deadtime file. The effects of deadtime correction are shown in section 2.7.

The options available for grouping and correcting data are shown below.

CHANGE	Change histogram grouping
READ	Read grouping table from disk
WRITE	Write grouping table to disk
DEADT	Switch deadtime correction on/off
ALPHA	Select (F-B) scaling factor
GUESS	Estimate alpha for a T20 run
BUNCH	Setting the bunching to ‘n’ adds ‘n’ bins together.
HELP	Display help text. (Don't panic)
EXIT	Return to UDA Data (main) menu

7.5. The Analysis Menu

The Analysis menu is entered by selecting the option ”Analyse” in the UDA Main menu. Using the options outlined below it is possible to select a model function and make a least squares fit of the model parameters. The results of the fit can also be plotted and output to an ASCII file.

SELECT	Select a group and a bin range to work on.
PLOT	Plot the data and the fit; allows fit to be written to an ASCII file
FIT	Run fitting routine using the starting values displayed in right hand window
HELP	Enter the help system at the Analysis menu level
VALUES	Enter the parameter display to change parameter values/status. To move in the parameter display use UP or DOWN cursor keys. To change a value use the ENTER key. Status codes are changed by typing ~ (vary parameter), ! (fix parameter), = (tie parameters together). Return to the menu by the left or right cursor keys.
THEORY	Select a theory function, number of sub-components and lineshape
ALPHA	Change value of alpha
UNDO	Undo fit and restore original parameters
EXIT	Exit this menu and return to the main UDA menu
WRITE	Write parameters out to a file
READ	Read parameters in from a file
DIST	Distribute parameters to all groups (necessary for transverse geometry)

7.6. Computer files

These files must be copied into the area you are working in. If the area has been selected by SETUP (as described in section 6.2) they will have been copied to the new area automatically.

SETUP.UDA	UDA reads some variables from the file SETUP.UDA. In particular the directory address of the data is set up in this way. Of particular interest are the FORTRAN format strings used to convert a run number to a full file name.
BASETIME.UDA	contains the value which UDA will use for time-zero (see section 2.6).
TRANS.UDA	default transversal grouping
LONG.UDA	default longitudinal grouping
PDF.UDA	parameter definition file
UDAHELP.HLP	help library source, UDA matters

7.7. Theory functions defined in UDA

A number of theory functions are predefined in UDA:

7.7.1. Longitudinal and zero field

Function Name	Definition
1. Lorentzian	$a_o \exp(-\lambda t)$
2. Gaussian	$a_o \exp(-(\lambda t)^2)$
3. LX(exp) - Stretched Exponential	$a_o \exp(-(\lambda t)^\beta)$
4. Keren LF (extended Abragam)	$a_0 \exp(-\Gamma(t)t)$; see note 1 below
5. Kubo-Toyabe (Gaussian)	$a_o(\frac{1}{3}+\frac{2}{3}(1-(\lambda t)^2)\exp(-(\lambda t)^2/2))$
6. Kubo-Toyabe (Lorentzian)	$a_o(\frac{1}{3}+\frac{2}{3}(1-\lambda t)\exp(-\lambda t))$
8. Dynamic Kubo-Toyabe	see note 2 below

Note 1:

$$\Gamma(t)t = \frac{2\Delta^2}{(\omega_s^2+\nu^2)^2}\{[\omega_s^2+\nu^2]\nu t+[\omega_s^2-\nu^2]\times[1-\exp(-\nu t)\cos(\omega_s t)]-2\nu\omega_s\exp(-\nu t)\sin(\omega_s t)\}$$

where UDA's sigma is equivalent to Δ, UDA's tau is equivalent to $1/\nu$ and $\omega_s=\gamma_\mu B_0$.

Note 2: Function 8, the dynamic Kubo-Toyabe, uses numerical integration to produce the fitting function and so requires more time than the other functions. Only fit up to channel 1000 when using this option.

7.7.2. Transverse field

Function Name	Definition
11. Lorentzian with freq	$a_o\cos(\omega t+\phi)\exp(-\lambda t)$
12. Gaussian with freq	$a_o\cos(\omega t+\phi)\exp(-(\lambda t)^2)$
13. LX(exp) - Stretched Exponential with freq	$a_o\cos(\omega t+\phi)\exp(-(\lambda t)^\beta)$
14. Abragam with freq	$a_o\cos(\omega t+\phi)\exp(-(\lambda\tau_c)^2(\exp(-t/\tau_c)-1+t/\tau_c))$

7.8. Time-zero

UDA reads the file *basetime.uda* to get the value of time zero used in the fits. See section 2.6 for the definition.

8. RF and other special setups

There are cables between the area and the cabin labelled X1,X2,X3.
In the cabin these cables come to the patch panel at the bottom of the rack, together with the Cerenkov signal (cable C3) and the Extract Trigger (cable EX3).

8.1. Timing and Acquisition

Normal setup: the Cerenkov goes via a discriminator to the Frame Start on the TDCs. Red/Green from the TDC can be connected via one of the cables to the RF rack. Usually the Extract trigger will be used to time the RF pulse.
Special setups: the Cerenkov or ISIS Extract Trigger signals can be used to trigger the RF, which in turn triggers the data acquisition.

8.2. The Lecroy TDCs

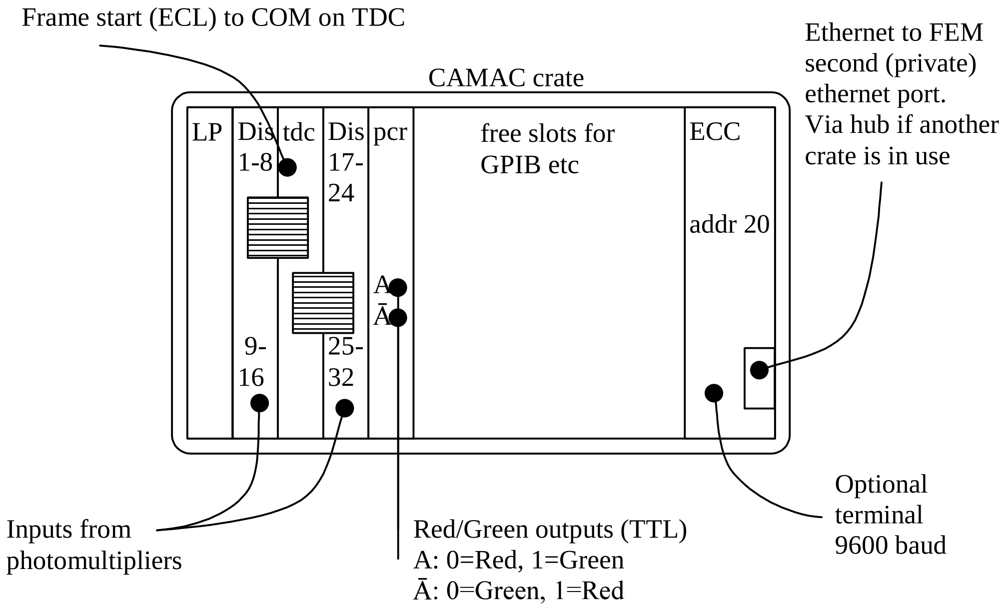
8.2.1. Specifications:

Bin width selectable 0.5 to 16ns in powers of 2 (non uniform below 2ns: care!)
32 histograms of up to 8192 bins each, for each of Red and Green
Maximum time length of histogram 32µs
Either frame-by-frame or block-at-a-time red-green mode can be used. In frame by frame mode you can select from n=1 to n=126 green frames for every red frame, giving red frame rates between 25 Hz and 0.4 Hz.
Note that the header of the saved file indicates the number of frames in the red histograms, but for n>1 the green histograms contain more frames worth of data. Take care when analysing this data, especially when applying dead time corrections.

8.2.2. CAMAC Modules:

LP: Hytec 1341 List Processor with 256k word data store
Dis: Lecroy 3412E discriminator
TDC: Lecroy 3377 time to digital converter
PCR: Nuclear Enterprises (Harwell) Preset Counting Register
ECC: Hytec 1365 Ethernet Crate Controller with 4M RAM

8.2.3. Connections



Notes:

- The List Processor must be in station 1 and the others adjacent to it as shown.
- No connections to the front panel of the List Processor
- Short ribbon cables between the discriminators and the TDC as shown.
- The Discriminators are usually in Manual operation, set the thresholds and widths on the front panel. Widths should be 10ns.
- The discriminators have 2 sets of outputs, the second can be used for other purposes, eg. fed to a DASH2, to check thresholds or timing, etc.
- No connection to the counter inputs of the PCR. Use the A outputs only.
- The TDC does NOT like a double start pulse as obtained directly from the Cerenkov counter. Use a first discriminator set to a very large pulse width which then drives a second one set to 10ns. Alternatively use one discriminator, with a second output triggering a timer set to 1µs, which is fed back to the Veto input of the discriminator.

8.2.4. Initialising

This should only be required if the crate has been switched off. The script “@LECROY” will do this, with some help from the user, otherwise:

- Stop MACQ if MCS is already running
- Disconnect the Frame Start pulse from the TDC (or disable it elsewhere)
- Reset the ECC: push the switch to Reset and back to Norm. Wait for it to initialise (10 seconds): message appears on the terminal if attached.
- $ ECCOP/SETLAM=3 20   (assuming crate address is 20)
- $ ECCOP/SETLAM=5 20
- $ ECCOP/COMMAND_LOAD=some$disk:[some.dir]LTDCFF.S /ID=4 20
- $ ECCOP/BOOK=1 20
  (this runs the downloaded code, more messages appear on the terminal)
- Reconnect or re-enable Frame Start. May give more messages on terminal.
- Now start MCS if it was not already running
- MCSCONF> SET MACQ /DEV=LTDC /CRATE=20 /FIRST=1 /NDEV=1 /NHIS=32
- MCSCONF> SET FREG /DEV=LTDC /CRATE=20 /STATION=1
- MCSCONF> SET SGATE/DELETE
- Start MACQ if it was stopped
- set resolution, histogram length, readout interval as required.

8.2.5. Setting up

To select the data acquisition mode:

- To enable Frame by Frame – n Green frames for every 1 Red

MCS> SET MACQ/RGMODE=n
(eg. SET MACQ/RGMODE=1 gives 25 Hz, SET MACQ/RGMODE=4 gives 10 Hz, etc)

- To collect data in blocks of red and green:

MCS> SET MACQ/RGMODE=0

- To turn off red/green completely – single set of histograms

MCS> SET MACQ/NORGMODE

Now collect data as usual!

8.2.6. Timing notes

In Frame by frame mode the Red/Green output changes after each frame, whether or not MCS wants the data. Therefore the lamp / RF pulse / etc runs at a steady frequency and any sample heating should be constant.

The output usually changes at about 175 µs after the Frame Start, but can be later if the crate controller was busy receiving data from the Ethernet when the TDCs finished collecting data. Do not use it as a time reference, only as a veto or enable signal.

When driving “slow” equipment such as the flash lamp from the previous frame’s Extract Trigger, the usual method is to use a delay set to about 19ms which then drives an adjustable delay of about 1ms. For correct operation, connect the Red/Green signal to the Veto of the last delay stage or the lamp itself. Vetoing the first 19 ms delay unit would get Red and Green the wrong way round (as compared to block red-green where this does not matter).

Once set up, Frame by frame mode actually turns on (or off) on starting the next run, when you type <return> or Y <return> to the “Clear Devices?” prompt.

8.2.7. Discriminators

These are normally set up manually from the front panel, with threshold levels of 50 or 75 mV and pulse width 10ns. Users should not need to change anything. However it is possible to use a program on the FEM to put these in Remote mode and then program the threshold levels.
Neither MACQ nor the downloaded program LTDCFF accesses them directly.

9. Troubleshooting

If you have to reset any equipment as described below, remember to tell your local contact as soon as possible – it may indicate that something is about to fail completely or needs repairing.

9.1. No muons (or far fewer than expected)

First check:

- The Frame Start light on the DTU module in the DASH2 TDC rack is lit - if not, the beam is off or there is no start pulse from the Cerenkov detector. Frame Start flashing means ISIS is at base rate (1/32 of 50Hz).
- If Frame Start is present, is the computer reading back from the electronics? Type SHOW RUN
- Is there any beam going to the other muon instruments?

9.1.1. Beam Off

Check the proton beam current – the big display in the hall or the ISIS PPP Monitor program on the PC. The last hour graph on the ISIS web page only updates every 10 minutes.

9.1.2. Kicker

The racks in the kicker control area (down the steps behind EMU) are:

Momentum slit (do not touch)	Kicker HV supply	Kicker monitor scope	Old UPPSET unit (not in use)
	Kicker main control panel		
Beam slits for each instrument	Thyratron	Separator HV supply	
HV for Cerenkov (start pulse) detectors			

If the kicker trips off, DEVA and EMU have no beam and MUSR will have a double pulse with twice the usual rate. Some lights will be lit on the control panel but the HV supply will be off. Instructions for resetting it are attached. Check with the other users before doing anything.
The kicker status is indicated in the MCR – someone from the crew may reset it.

9.1.3. Beamline Magnets

When one of these trips the beam may be lost completely or just reduce in rate and have a huge spot size.
Magnets Q1-Q9, B1/2 and the Separator are common to all three beamlines. B1/2 goes off if any of the Muon Beam Off buttons are pressed, and the white lights will come on in all the areas. Warning: it is possible to press a button gently (accidentally) without it latching in yet trip the beam.
Septum A and Q10A-Q12A are for the DEVA branch only. B is MUSR, C is EMU.
The Switchyard magnets are normally off .
The magnet supplies are located on the platform at the far end of the hall. Each position is labelled with the required current for that magnet.

Reset1	Separat	Q4	Q8		DEVA	DEVA	EMU	Reset2	Q10A	spare	Q10C
	Q2	Q6	Q9		Helm-	Septum	Septum		Q11A	Q11B	Q11C
Q1	on/off	on/off	on/off		holtz	A	C	PLC	on/off	on/off	on/off
	Q3/5	Q7	B1/2						Q12A	Q10B	Q12C
spares	spares		spare							SWY1	SWY2

Reset1: interlocks with reset buttons for Q1-Q9, B1/2 and the Separator supplies
Reset2: interlock reset buttons for Q10A-Q12C, Septum, Switchyard and instrument magnets.

on/off: panel with ON and OFF buttons for the power supplies.
spare: Spare supplies, not connected or powered up. (ISIS staff use only!)
The PLC has status lights for the second group of magnets and for the shutters: the upper row of modules show inputs from various sensors and switches and the lower row is the outputs to enable the supplies. For interlocks the general rule is Lights ON = good, lights OFF = tripped.

Farnell supplies: press the interlock reset buttons then the green ON button next to the power supply. It should not be necessary to touch the controls on the supply itself. Check it returns to the setpoint and the green “Output Enable” light is on.
Danfysik supplies (septum): press the interlock reset buttons, then on the supply itself press OFF/Reset and then ON. Check the setpoint and readback values.
The Separator electric field is provided by the Glassman unit in the rack next to the kicker. The usual value is 90kV.

9.1.4. Photomultipliers

These are powered from the Lecroy HV supply in the cabin.
Turn all channels on or off with the HV ON and HV OFF buttons.
The Cerenkov start counter is supplied from the HV supply next to the slit controls – check the other instruments are counting data OK.

9.1.5. Beamline Vacuum

This is monitored on the rack on the platform, above the target/kicker control area. Check that the vacuum in the beamlines is OK (about 10^{-6} mbar or better) and that all the valves are open except for those labelled “vent” and “bypass”. The “line” valve in each branch of the beamline is linked to that instrument’s shutter. Do not attempt to open or close valves – ask your local contact or the MCR for advice.

9.1.6. RF triggering

Is the data acquisition being triggered from the RF zero crossing – if so is it working properly?

9.1.7. Computer

There may be muons but the computer is not reading back from the electronics. See below.

9.1.8. Blocker Closed ?

The blue lights in the area will light if the blocker has been opened correctly.

9.2. Strange data

9.2.1. Light leaks

On an asymmetry vs. time plot this gives asymmetry going to +100% or –100% at later times.
If a detector develops a light leak (large background number of counts in the later time bins) turn its voltage off to prevent damage.

9.2.2. Beamline Magnets

If a beamline magnet trips there may still be muons but the spot size could be huge and the asymmetry change to an implausible value. Reset it as above.

9.2.3. RF pickup

With high RF pulse power, it can be picked up by the detector wiring. This may change the sensitivity of th electronics when counting actual events or even make it count cycles of the RF waveform. First try to improve the shielding of the coil or insulate it from the spectrometer's metal framework. Changing frequency (if possible) often helps as the pickup is via resonances in the cables etc.
If the problem is not too severe, just remove that histogram from the grouping when analysing the data. If it has a huge count rate it may be necessary to disconnect that detector from the electronics in the cabin, so that the total counts in the run correspond to usable events.

9.3. Computer

The PF1 key locks/unlocks the screen (or the currently selected Decterm window). This can give the appearance of a crash, and can actually cause a crash if left locked for too long.

Many problems with MCS can be cleared by restarting it:

- first SAVE the current run. If it refuses to do this, you have to kill MCS itself from another Decterm window.
- type EXIT
- Wait a few seconds for all the windows to disappear
- If any remain, type SHOW SYSTEM to get the list of processes. Look for MTEMP, MMAG, MACQ, MWSDISPLAY and MWSWINDOWS. Kill them with STOP /ID=*nnnnnnnn* where *nnnnnnnn* is the number to the left of the process name.
- type MCS to restart.

No communication with the data acquisition hardware: from MCS type SYS SHOW SYSTEM and look for the process name ecc_1365. If missing, it usually requires a reboot to get it going again. Warning: closing the DECterm window in which MCS is running using the "close" icon usually kills the ecc_1365 process!

No communication with Labview: from MCS type SYS SHOW SYSTEM and look for the process name DCOM$RPCSS. If missing, it usually requires a reboot to get it going again. If you find DCOM$STARTUP-** instead, this indicates it has failed to initialise correctly: in this case contact Computer Support.

If all else fails, there is a reset button on the Alpha workstation. Log out first if possible, then press this to reboot.

9.4. Magnets

9.4.1. Main field

If the Danfysik Longitudinal field supply trips, MCS will print error messages every few seconds. One or more red LEDs will light on the supply control panel. Pressing the buttons next to them will indicate exactly what it thinks is the problem. MAG Overtemperature can mean the "Helmholtz Interlock" key by the door.

- In MCS type @F0 to stop the error messages.
- Clear the problem: if it was the door interlock, close the door and raise the blocker. If a problem with water flow, press the three reset buttons on the interlock PLC rack.
- Reset the power supply: press LOCAL to make the Remote light go out, then OFF/RESET which should turn off any red lights, then Remote.
- In MCS type @LF0
- Then type SET MAG/SET=*xxx* to go back to your setpoint.

9.4.2. Zero field

The Zero field program on the PC will give a status message of "Current Overload" if it is unable to reach zero (or its setpoint). This may be due to:

- Set point too large: the maximum available from the coils is about ±1 Gauss (1000 mG as shown on the PC) in each Transverse direction and ±3G in Longitudinal. The magnetometer range is ±5G.
- The main LF or T20 magnet is on: this should not happen if controlled from MCS.
- There is a fault with the coils or magnetometer.

9.5. Temperature control

9.5.1. Needle Valve

Sometimes the ITC temperature controllers can lose the zero position on the motorised valve, leading to excessive helium use and high heater power with the valve reading 0%, or the temperature drifting up with the valve apparently at 99%. The latter could also be due to an empty dewar. To reset:

- Switch the ITC off and on again
- Wait for it to initialise the valve (light flashing)
- Re-send the setpoint with SET TEMP/SET=*ttt*

9.5.2. Empty Dewar

Don't let the dewar run dry if possible! If this happens:
Turn off the diaphragm pump immediately.
Check the pressure gauges on the dewar and the pump control box. If below atmospheric you have to admit clean helium from the supply on the panel via the red valve on the dewar. Gas will come out of the green non return valve once you are back at atmospheric pressure. It may take several minutes.
Now remove the transfer line as usual and change to a new dewar.

10. Contacts and further information

Address:
ISIS Facility
Rutherford Appleton Laboratory
Chilton
Didcot
Oxon OX11 0QX
U.K.

Phone (Main switchboard) 01235 821900
Fax (User Office) 01235 445103
Fax (ISIS Staff) 01235 445720
Web page http://www.isis.rl.ac.uk/muons/

Ordinary phone extensions (starting with 5 or 6) can usually be dialled from outside the lab with 01235 44+ext or +44 1235 44+ext from abroad. Mobile short codes starting with 1 only work on the RAL exchange.
To make outgoing calls just dial the full number. There is no need to add a leading "9".

10.1. Muon Group

	Office phone	Mobile short code	E-mail
Dr. Steve Cottrell	5352	1665	S.P.Cottrell@rl.ac.uk
Prof. Steve Cox	5477		S.Cox@rl.ac.uk
Dr. Gordon Eaton	5464		G.H.Eaton@rl.ac.uk
Dr. Adrian Hillier	6001	1476	A.D.Hillier@rl.ac.uk
Dr. Clive Johnson	6259		C.Johnson@rl.ac.uk
Dr. Philip King	6117	1716	P.J.C.King@rl.ac.uk
Dr. James Lord	5674	1101	J.S.Lord@rl.ac.uk
Dr. Francis Pratt	5135	1114	F.Pratt@rl.ac.uk

10.2. Useful Phone numbers (RAL)

ISIS Main Control Room (MCR)	6789
Emergencies: Fire/Ambulance	2222
Occupational Health (minor illness)	6666
Security lodge (main gate)	5545
Health Physics (sample checking)	6696
DEVA Cabin	6851
MUSR Cabin	6135
EMU Cabin	6831
ARGUS (RIKEN) Cabin	6766
User Office	5592
Local taxi bookings to B&B or station	User Office 5592 in working hours, MCR 6789 out of hours
Airport transport	User Office 5592 – give 24 hours notice.
Technical support	see the list in the cabin. Out of working hours phone the MCR who will contact someone on call.
Computer support	1763 (working hours)

10.3. Transport

Trains			
National Rail Enquiries	08457 484950	http://www.railtrack.co.uk/	It is usually possible to arrange a taxi to either Didcot or Oxford station.
Buses			
Oxford Bus Company	01865 785410	http://www.oxfordbus.co.uk/	Local buses and coaches to London and the airports
Stagecoach	01865 772250	http://www.stagecoach-oxford.co.uk	Local buses – some serve the Harwell Business Centre bus park opposite the RAL main gate
Air			
BAA		http://www.baa.co.uk/	Flight arrival/departure information for Heathrow and Gatwick airports

10.4. General Information

Oxford Tourist Information Centre	01865 726871
Oxford Guide on the Web	http://www.comlab.ox.ac.uk/archive/ox/

10.5. Eating and Drinking

Didcot Tandoori, 222 Broadway, Didcot	01235 812206
Cherry Tree Inn, Steventon	01235 831222
The Crown and Horns, East Ilsley	01635 281205
Fleur de Lys, East Hagbourne	01235 813247
The George and Dragon, Sutton Courtenay	01235 848252
The Great Western Junction Hotel, Didcot	01235 511091
The Hare Inn, West Hendred	01235 833249
The Harrow, West Ilsley	01635 281260
The Plough, Sutton Courtenay	01235 848801
Red Lion, Drayton	01235 531381
Rose and Crown, Chilton	01235 834249
The Swan Inn, Sutton Courtenay	01235 847446
The Wheatsheaf Inn, East Hendred	01235 833229